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ORIGINAL

# FLOOD INSURANCE STUDY

## MORTON COUNTY, NORTH DAKOTA
## UNINCORPORATED AREAS

SEPTEMBER 30, 1987

Federal Emergency Management Agency

COMMUNITY NUMBER - 380148

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NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for flood plain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.



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Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map



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# 1.0 INTRODUCTION

## 1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the unincorporated areas of Morton County, North Dakota, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert Morton County to the regular phase of the National Flood Insurance Program (NFIP) by the Federal Emergency Management Agency (FEMA). Local and regional Planners will be using this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

## 1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for the Missouri River were performed by the U.S. Army Corps of Engineers (COE), Omaha District (References 1 and 2). The hydrologic and hydraulic analyses for the Heart River were performed by the COE in 1985.

The approximate analyses for this study were performed by Barr Engineering Company, for FEMA, and were completed in 1979.

## 1.3 Coordination

In 1983, the COE submitted to FEMA hydrologic and hydraulic analyses for the Missouri River. In 1985, the COE submitted to FEMA hydrologic and hydraulic analyses for the Heart River. FEMA approved the preparation of a Flood Insurance Study for Morton County using the COE analyses of the Missouri and Heart Rivers and the approximate analyses performed by Barr Engineering Company.

The final community coordination meeting was held on April 7, 1981, and was attended by representatives of FEMA, the study contractor, and the county. All significant problems raised at that meeting have been addressed in this study.



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## 2.0 AREA STUDIED

### 2.1 Scope of Study

This Flood Insurance Study covers the unincorporated areas of Morton County, North Dakota with the exception of the areas of extraterritorial jurisdiction of the City of Mandan. The area of study is shown on the Vicinity Map (Figure 1).

Flooding along the Missouri River was studied by detailed methods from approximately 1.9 miles downstream of its confluence with the Little Heart River upstream to the Morton-Oliver County boundary.

The Heart River was studied by detailed methods from its confluence with the Missouri River to approximately 1,500 feet upstream of the U.S. Highway 10 bridge located 3 miles west of Mandan.

The areas studied by detailed methods were selected based on the extent and validity of available hydrologic and hydraulic data.

Approximate methods were used to study the Heart River from the U.S. Highway 10 bridge 3 miles west of Mandan, upstream to the Heart River intersection with the Grant County-Morton County limits.

The Cannonball River was studied by approximate methods from approximately 1 mile upstream of its confluence with Lake Oahe (east section line of Section 19, T. 134 N., R. 79 W.) upstream to the Morton-Grant County boundary.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards.

### 2.2 Community Description

Morton County is located in south-central North Dakota. The adjacent counties are Mercer and Oliver to the north, Burleigh and Emmons to the east, Grant and Sioux to the south, and Stark to the west.

The population of Morton County in 1980 was 25,177 (Reference 3).

Residential and commercial development is concentrated in the incorporated areas of Morton County. The largest single concentration of development occurs in the City of Mandan in the northeastern portion of the county. The Cities of Glen Ullin and Hebron, located in the western portion of the county, are other large concentrations of development. Interstate Highway 94 passes east to west through the northern portion of the county. State Highways 94, 31, 25, 6, and 1806 provide the major north-to-south routes, with the majority of remaining residential and commercial concentrations along these highways and Interstate Highway 94.



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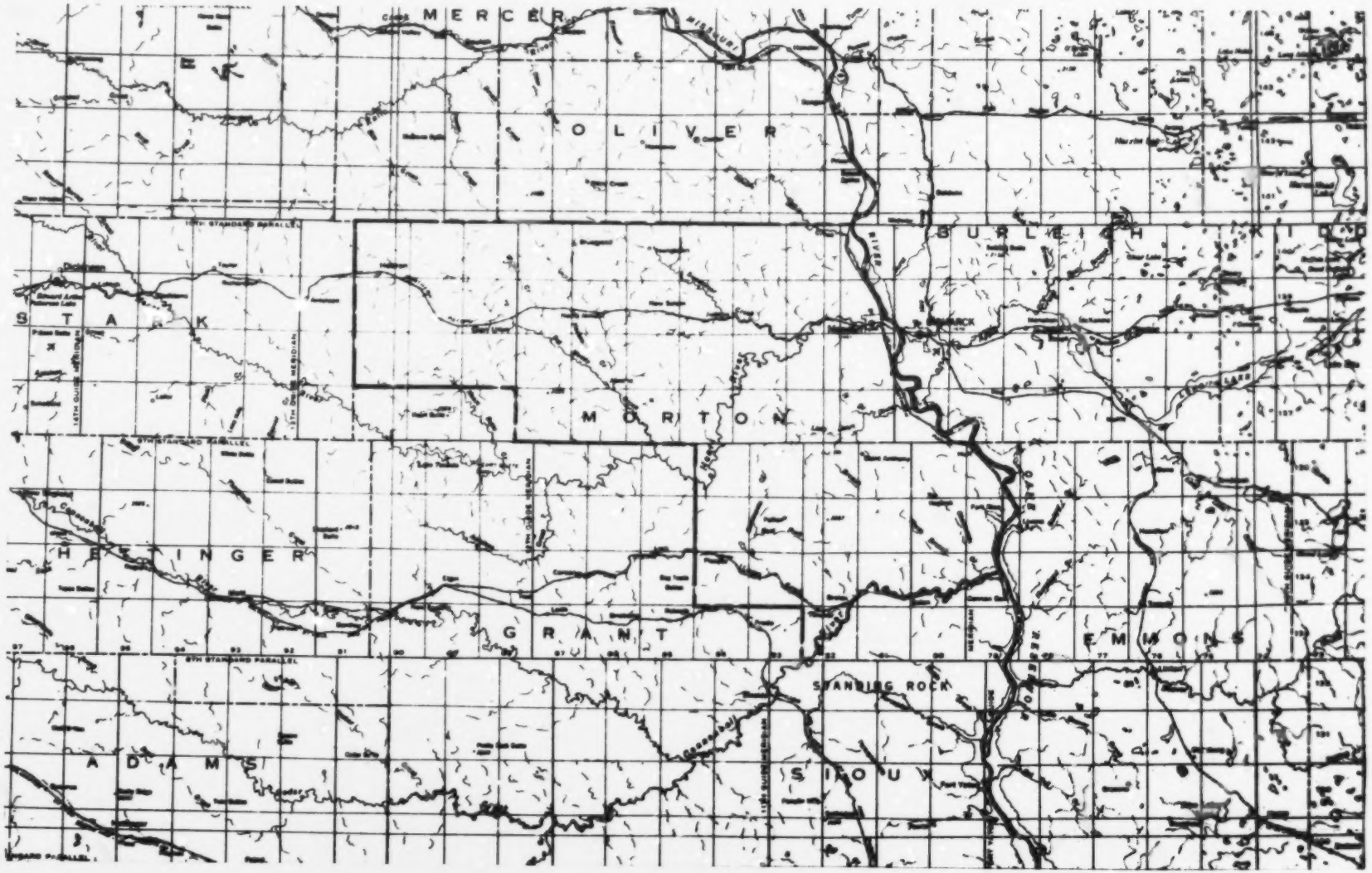


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORTON COUNTY, ND
(UNINCORPORATED AREAS)

APPROXIMATE SCALE

16 0 16 32 48 MILES

VICINITY MAP

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The majority of the flood plain within the study area is open space, cropland, and rangeland; however, some residential, roadway, and commercial development is located within the Missouri River and Heart River flood plains, particularly in the vicinity of Mandan.

Agriculture is the major land use in Morton County. Cultivated land predominates, with steep slopes and areas of shallower soils used as rangeland for livestock. Residential, commercial, and industrial development is centered in incorporated areas of the county.

The average high temperature from May to September in Morton County is 78°F; the low monthly average is 51°F. From October through April, the average high temperature is 37°F; the average low temperature is 15°F.

Morton County receives an average annual precipitation of 15 inches, including an average annual water content in snow of 4 inches.

The majority of Morton County is undulating, rolling uplands. Some hilly and steep lands occur throughout the county; the major hilly and steep lands occur in the eastern and central portions of the county, along the Heart River and Sweetbriar Creek. The average difference in elevation between ridgetops and stream valleys is approximately 215 feet. The county has a general west-to-east slope, dropping in elevation from approximately 2,400 feet to approximately 2,150 feet.

Morton County is at the western edge of the glaciated portion of North Dakota. Glacial till covers most of the county. Very little evidence of glaciation exists in the southwestern portion of the county; however, glacial boulders are prevalent throughout the remainder of the county. A layer of gravelly clay till covers the extreme northeastern corner of the county.

The soils that are found in the majority of the dominating undulating, rolling uplands of Morton County vary in texture from fine sands to clay loams, and from comparatively porous and droughty soils to compact and relatively impervious soils. Fine-grained soils (some poorly drained) are found along flood plains and outwash channels (Reference 4).

Vegetation in upland areas of Morton County consists of cultivated crops interspersed with native grasses and shrubs. Native trees and shrubs are common along the creek and river bottom lands and in some ravines.



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The drainage system of Morton County is well defined. The Heart River provides the surface drainage in the central portion of the county, and the Cannonball River provides surface drainage in the southern portion of the county. These two rivers and their tributaries drain the majority of the county to the Missouri River, with all of the county draining into the Missouri River along the eastern county border. Dams located on tributaries of the Heart River regulate flow on the Heart River. The Garrison Dam located on the Missouri River upstream of Morton County regulates flow on the Missouri River.

## 2.3 Principal Flood Problems

Short-duration, high-intensity spring rainstorms in combination with snowmelt and ice jams are the principal cause of flooding on the Missouri, Heart, and Cannonball Rivers in Morton County.

Major flooding occurred on the Missouri River in 1881, 1887, 1910, 1917, 1938, 1939, 1943, 1947, 1950, and 1952. The April 6, 1952, flood reached an elevation of 1,646.28 feet at the U.S. Geological Survey (USGS) gage at Bismarck, North Dakota. The March 31, 1881, flood reached an elevation of 1,649.8 feet at this gage (References 5 and 6). Since the completion of Garrison Dam in 1953, floods of this magnitude would have a recurrence interval greater than 500 years.

The severity of ice jams has decreased since construction of Garrison Dam, but the potential for severe river blockage still exists. The maximum peak discharge that has occurred since 1953 on the Missouri River was 68,900 cubic feet per second (cfs) at the USGS stream gaging station at Bismarck. This occurred on July 13, 1975, with an estimated recurrence interval of 75 years. The most recent flood of record occurred in May 1980 and had a peak discharge of 18,900 cfs (Reference 2).

Major floods on the Heart River occurred in 1950, 1952, and 1969. The April 1950 flood reached an elevation of 1,662.34 feet at the USGS Heart River gage near Mandan (Reference 7).

Floods on the Missouri and Heart Rivers have destroyed roads, croplands, and rural buildings; killed livestock; interrupted utility services; and destroyed residential and commercial properties, particularly in Mandan.

Increased flood hazard from ice jams has been a significant problem on the Heart River almost every year during the late 1970s. The major problem occurs when the Missouri River remains frozen as the ice breaks up on the Heart River. Ice jams have occurred along the entire reach of the Heart River in the vicinity of Mandan. The most critical area is located upstream of the Burlington Northern Railroad bridge and downstream of the North Dakota State Highway 1806 bridge.



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The current method for mitigating the Heart River ice jam problem is reducing the Missouri River stage by significantly reducing the discharge from the Garrison Reservoir, which is 74 miles upstream from the confluence with the Heart River. The reduced stage on the Missouri River allows the Heart River ice to flow more freely into the Missouri River.

Because of the chronic ice jam problem, the Lower Heart River Watershed District has strongly urged that the entire Heart River flood plain from the vicinity of Mandan to the mouth of the river remain unobstructed.

### 2.4 Flood Protection Measures

Fort Peck Dam (Missouri River, northeastern Montana) and the Garrison Dam (Missouri River, central North Dakota) significantly reduce peak discharges and elevations on the Missouri River in Morton County.

A levee system along the Heart River was constructed by the COE in 1950 to protect Mandan from floods. The levee system is divided into three units: the Sunny Unit, the Mandan Unit, and the Lower Unit. The Sunny Unit, located to the west of Mandan, consists of a closure levee and U.S. Highway 10, which functions as a levee. The Mandan Unit is a levee system protecting the Training School on the western bank of the Heart River and protecting Mandan along the eastern and northern banks of the river. The Lower Unit is located in the southern portion of Mandan, along the eastern bank of the Heart River.

These levees may not protect the community from rare events such as the 100-year ice-affected flood. The criteria used to evaluate 100-year flood protection are as follows: (1) adequate design, including freeboard, (2) structural stability, and (3) proper operation and maintenance. Levees that do not provide 100-year flood protection have not been considered in the hydraulic analysis of the 100-year flood plain.

## 3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average



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period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

## 3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

Discharges for the 10-, 50-, 100-, and 500-year floods on the Heart River were determined by the COE. Discharges for the all-season events of the selected recurrence intervals were obtained from a log-Pearson Type III analysis of the gage on the Heart River near Mandan (USGS gage No. 06349000).

Because the most severe flood potential for the Heart River in the vicinity of Mandan occurs from discharges resulting from snowmelt occurring coincidently with ice-jam conditions, COE also developed a peak discharge-frequency relationship for the snowmelt season for the Heart River. This relationship was developed using a graphical best-fit procedure related to the all-season curve. Discharges determined for the snowmelt season were used in the hydraulic analysis of the Heart River.

COE made extensive hydrologic study of the Missouri River at Bismarck in 1973 for use in Flood Plain Information, Missouri River, Bismarck-Burleigh County, North Dakota, (Reference 5). An updated check of the gaging records used for that report indicated that no significant changes have occurred in the natural flow regime; however, added experience in the operation of the Missouri River Main Stem Reservoirs under system-full conditions has provided a basis for improving the predictability of the releases from Garrison Reservoir, as well as the pool level of Oahe Reservoir during high inflows. Therefore, the hydrology for the Upper Oahe-Bismarck area studies has been adjusted to reflect these refinements in the potential operating procedures (Reference 1).

To provide starting water-surface elevations for the hydraulic analysis, a coincident pool level study was made in November 1982. That is study related the Missouri River at Bismarck and the Heart River at Mandan combined discharges with historical pool levels.



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The study was made for the 1968-to-1980 period, and it provides the expected level of Oahe Reservoir at the time that the peak discharge of a given flood is occurring in the Bismarck area.

There has been a history of ice-affected flooding in the study reach. To verify that the water-surface profiles developed in the hydraulic analysis reflect an all-season condition, a stage-probability analysis was done at the Missouri River USGS stream gages at Bismarck (No. 6342500), Mandan (No. 6349070), and Schmidt (No. 6349700). At each gage an all-season stage-probability curve was developed. The curve is a combination of open-water season floods from Garrison Dam operations; open-water season floods from the Knife River, the Heart River, and other residual drainage areas below Garrison Dam combined with coincident releases from Garrison Dam; and ice-affected floods from Garrison Dam operations.

The stage-probability curve for each of the annual flood conditions was determined graphically using Weibull's Plotting Position Formula for all events except the 1975 open-water event from Garrison Dam operations. The all-season stage-probability curves were developed at each location by combining conditions a, b, and c using the following formula:

$$P_{\text{All-season}} = 1 - (1-P_a)(1-P_b)(1-P_c)$$

Peak discharge-drainage area relationships for the Missouri and Heart Rivers are shown in Table 1.

## 3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Water-surface elevations on the Missouri and Heart Rivers were determined using the COE HEC-2 step-backwater computer program (Reference 8).

Starting water-surface elevations for the Missouri River were obtained by extending the HEC-2 backwater model downstream into Oahe Reservoir. As part of the hydrologic analysis, a coincident pool level study was made to determine the expected level of Oahe Reservoir at the time the peak discharge of a given flood was occurring in the Bismarck area. The elevations determined from this analysis were used as starting water-surface elevations in the HEC-2 backwater model. The starting water-surface elevations for the Heart River were based on the Missouri River profile.

Cross section data and bridge dimensions and elevations were obtained from field surveys, the U.S. Soil Conservation Service, the North Dakota State Highway Department, and topographic mapping (References 9 and 10).



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Table 1. Summary of Discharges

| Flooding Source and Location | Drainage Area (Square Miles) | Peak Discharges (Cubic Feet per Second) 10-Year | 50-Year | 100-Year | 500-Year |
|---|---|---|---|---|---|
| Missouri River | | | | | |
| Below Heart River Confluence | 189,710 | 68,500 | 104,000 | 121,500 | 193,000 |
| Above Heart River Confluence | 186,400 | 57,000 | 81,500 | 94,000 | 148,000 |
| Heart River | | | | | |
| At U.S. Highway 10 | 3,310 | 16,000[1] | 31,000[1] | 41,000[1] | 66,000[1] |

[1]Snowmelt Season Only

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Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Channel Roughness (Manning's "n") values for the Missouri River were determined by matching rating curves at USGS stream gages and reconstituting historical floods. In this analysis, it was found that for higher discharges, the roughness value had to be reduced to match historical data. Overbank values were determined by field inspection and review of photogrammetric maps (Reference 10). Roughness values for the Missouri River varied from 0.023 to 0.025 in the channel and from 0.060 to 0.120 in the overbanks. Roughness values for Heart River were based on field inspection and photographs of the area. Overbank values ranged from 0.030 to 0.100. Channel values ranged from 0.032 to 0.035.

Most of the levees along the Heart River in the Sunny, Mandan, and Lower Units provide 100-year flood protection during open-water events. However, because snowmelt flood discharges are often accompanied by ice jams, an additional ice increment was added to the snowmelt discharge water-surface profiles. This ice increment was determined by plotting open-water and ice-affected stages on the rating curve developed for the Mandan gage. An eye-fit curve was drawn through the ice-affected stages and the difference between this ice-affected curve and the computed curve for the selected recurrence intervals was added to the Heart River snowmelt water-surface profiles.

The resulting Heart River ice-affected profiles were compared with high-water marks taken through the Mandan Unit in 1978 and found to be acceptable. In the Lower Unit, the ice-affected profiles were found to be significantly lower than high-water marks from the 1972 and 1978 ice-jam floods. These high-water marks were used to develop an ice increment to be added to the profiles in the Lower Unit to better replicate historical flood events. The ice-affected 100-year water-surface elevations exceed the 3-foot minimum freeboard required to credit levees with 100-year flood protection. As a result, the levees along the Heart River were not considered to provide effective 100-year ice-affected flood protection. Therefore, an additional hydraulic analysis was performed to remove the levees from the analysis. Elevations of the 100- and 500-year floods were computed for the Heart River, without consideration of levees, using the COE HEC-2 step-backwater computer program (Reference 8). The additional ice increment was not added to the without-levee water-surface profiles because ice jams would not have a significant effect on the wider, without-levee flood plain. The results of this without-levee analysis indicate that there are no areas outside of the extraterritorial jurisdiction of the City of Mandan that are protected by the levee system from



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the combination of ice jams, and flows exceeding the 100-year ice-affected discharge.

The ice-affected 500-year water-surface elevations for the Heart River were found to overtop most levees. Therefore, a 500-year profile is not shown on the with-levee profiles.

Profiles labeled "Heart River-With Consideration of Levees" represent elevations developed for the entire study reach, under the assumption that the levees do not fail.

For streams studied by approximate methods, normal-depth calculations were used to establish approximate depths of flooding.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

## 4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

### 4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, enlarged to 1:12,000 and 1:2,400, with contour intervals of 10 and 2 feet, respectively (References 9 and 10).

Along most of the Heart River, the 500-year flood plain boundaries were delineated assuming that no levees exist.

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.



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For streams studied by approximate methods, flood plain boundaries were delineated on topographic maps at a scale of 1:24,000, with a contour interval of 20 feet (Reference 11).

## 4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces the flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

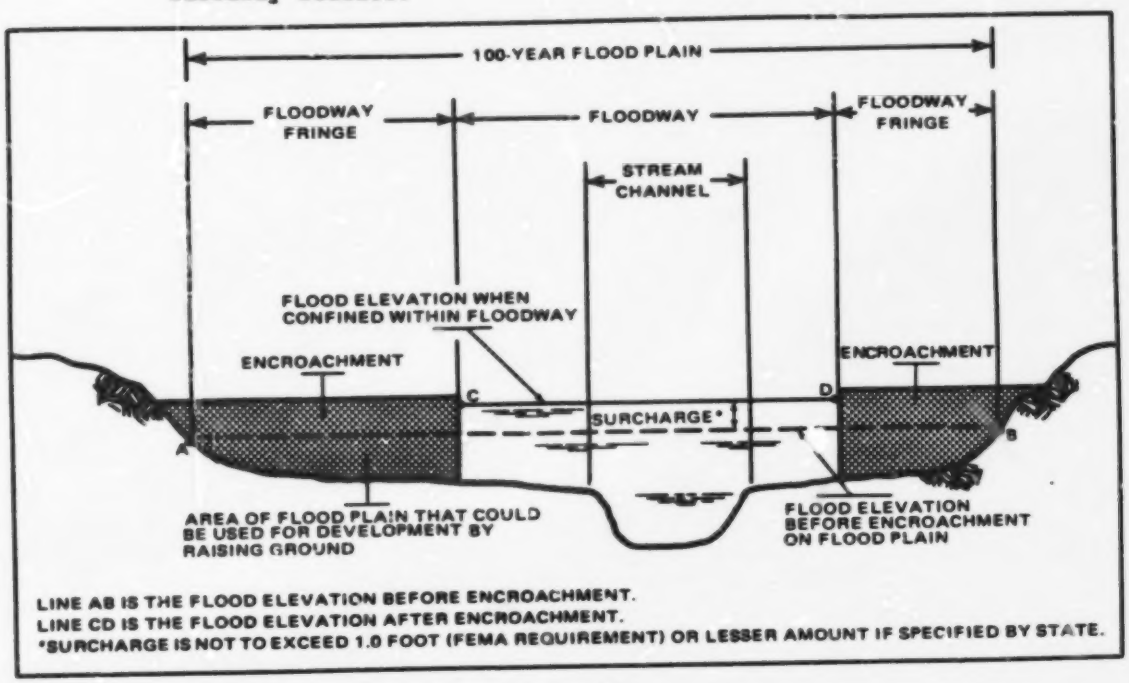
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

**Figure 2. Floodway Schematic**



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| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH[2] (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | (FEET NGVD) | | | |
| Missouri River | | | | | | | | |
| A | 6,867,802 | 2,118/ 729 | 30,558 | 4.0 | 1,627.7 | 1,627.7 | 1,628.3 | 0.6 |
| B | 6,870,283 | 1,935/ 542 | 24,806 | 4.9 | 1,627.9 | 1,627.9 | 1,628.5 | 0.6 |
| C | 6,872,976 | 2,251/ 1,001 | 33,850 | 3.6 | 1,628.5 | 1,628.5 | 1,629.4 | 0.9 |
| D | 6,875,722 | 1,970/ 1,210 | 31,433 | 3.9 | 1,628.7 | 1,628.7 | 1,629.6 | 0.9 |
| E | 6,878,731 | 2,665/ 1,732 | 39,711 | 3.1 | 1,629.1 | 1,629.1 | 1,630.0 | 0.9 |
| F | 6,880,738 | 2,290/ 1,395 | 35,788 | 3.4 | 1,629.2 | 1,629.2 | 1,630.1 | 0.9 |
| G | 6,883,589 | 1,883/ 992 | 28,070 | 4.3 | 1,629.5 | 1,629.5 | 1,630.4 | 0.9 |
| H | 6,885,490 | 2,930/ 1,615 | 41,062 | 3.0 | 1,629.9 | 1,629.9 | 1,630.8 | 0.9 |
| I | 6,886,968 | 2,550/ 1,245 | 37,427 | 3.2 | 1,630.0 | 1,630.0 | 1,630.9 | 0.9 |
| J | 6,890,558 | 2,180/ 1,790 | 29,957 | 4.1 | 1,630.6 | 1,630.6 | 1,631.4 | 0.9 |
| K | 6,894,413 | 2,630/ 1,510 | 36,141 | 3.4 | 1,631.1 | 1,631.1 | 1,632.1 | 1.0 |
| L | 6,895,891 | 2,035/ 1,269 | 33,107 | 3.7 | 1,631.3 | 1,631.3 | 1,632.2 | 0.9 |
| M | 6,898,478 | 2,192/ 1,096 | 35,589 | 3.4 | 1,631.4 | 1,631.4 | 1,632.4 | 1.0 |

[1]Feet Above Mouth

[2]Width/Width Within Study Area

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORTON COUNTY, ND
(UNINCORPORATED AREAS)

**FLOODWAY DATA**

MISSOURI RIVER

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| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH[2] (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | (FEET NGVD) | | | |
| Missouri River (Cont'd) | | | | | | | | |
| N | 6,900,221 | 2,985/ 1,523 | 42,397 | 2.9 | 1,631.6 | 1,631.6 | 1,632.6 | 1.0 |
| O | 6,902,861 | 2,760/ 990 | 40,992 | 3.0 | 1,631.9 | 1,631.9 | 1,632.8 | 0.9 |
| P | 6,905,221 | 3,210/ 1,005 | 39,223 | 3.1 | 1,632.1 | 1,632.1 | 1,633.0 | 0.9 |
| Q | 6,907,507 | 2,828/ 790 | 35,676 | 3.4 | 1,632.2 | 1,632.2 | 1,633.2 | 1.0 |
| R | 6,910,781 | 2,785/ 1,242 | 42,880 | 2.8 | 1,632.5 | 1,632.5 | 1,633.5 | 1.0 |
| S | 6,913,474 | 2,054/ 877 | 29,950 | 4.1 | 1,632.7 | 1,632.7 | 1,633.7 | 1.0 |
| T | 6,915,955 | 2,131/ 915[2] | 37,921 | 3.2 | 1,633.0 | 1,633.0 | 1,634.0 | 1.0 |
| U | 6,918,120 | 1,634/ 867[2] | 24,601 | 4.9 | 1,633.1 | 1,633.1 | 1,634.1 | 1.0 |
| V | 6,920,620 | 2,017/ 988[2] | 32,633 | 3.7 | 1,633.8 | 1,633.8 | 1,634.6 | 0.8 |
| W | 6,922,555 | 1,727/ 877[2] | 26,103 | 4.7 | 1,634.0 | 1,634.0 | 1,634.8 | 0.8 |
| X | 6,924,456 | 1,540/ 645[2] | 25,711 | 3.7 | 1,634.2 | 1,634.2 | 1,635.2 | 1.0 |
| Y | 6,926,146 | 1,479/ 825[2] | 25,239 | 3.7 | 1,634.3 | 1,634.3 | 1,635.3 | 1.0 |
| Z | 6,968,966 | 1,773/ 890[2] | 25,741 | 3.7 | 1,638.8 | 1,638.8 | 1,639.3 | 0.5 |

[2]Feet Above Mouth

[2]Width/Width Within Study Area

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORTON COUNTY, ND
(UNINCORPORATED AREAS)

FLOODWAY DATA

MISSOURI RIVER

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | (FEET NGVD) | | | |
| Missouri River (Cont'd) | | | | | | | | |
| AA | 5,982,747[1] | 3,351/ 1,325[2] | 38,432 | 2.4 | 1,640.0 | 1,640.0 | 1,640.4 | 0.4 |
| AB | 5,989,030[1] | 4,221/ 1,999[2] | 41,699 | 2.3 | 1,640.4 | 1,640.4 | 1,640.8 | 0.4 |
| AC | 5,998,798[1] | 1,620/ 910[2] | 24,527 | 3.8 | 1,641.2 | 1,641.2 | 1,641.5 | 0.3 |
| AD | 7,005,451[1] | 2,036/ 1,000[2] | 24,067 | 3.9 | 1,642.1 | 1,642.1 | 1,642.3 | 0.2 |
| AE | 7,015,219[1] | 1,337/ 506[2] | 19,540 | 4.8 | 1,643.6 | 1,643.6 | 1,643.7 | 0.1 |
| Heart River | | | | | | | | |
| A | 3,020[3] | 2,557 | 14,425 | 2.8 | 1,638.8[4] | 1,635.5[5] | 1,635.5[5] | 0.0 |
| B | 46,905[3] | 2,195/ 345[2] | 21,073 | 1.9 | 1,663.2[4] | 1,661.5[5] | 1,661.5[5] | 0.0 |
| C | 54,205[3] | 1,591 | 14,446 | 2.8 | 1,665.2[4] | 1,663.5[5] | 1,663.5[5] | 0.0 |
| D | 58,365[3] | 1,983 | 12,030 | 3.3 | 1,669.2[4] | 1,667.4[5] | 1,667.4[5] | 0.0 |

[1]Feet Above Mouth [2]Width/Width Within Study Area

[3]Feet Above Confluence With Missouri River [4]Computed With Ice Effects [5]Computed Without Ice Effects

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORTON COUNTY, ND
(UNINCORPORATED AREAS)

**FLOODWAY DATA**

**MISSOURI RIVER-HEART RIVER**

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## 5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting Morton County.

### 5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

| Average Difference Between 10- and 100-Year Floods | Variation |
|---|---|
| Less than 2 feet | 0.5 foot |
| 2 to 7 feet | 1.0 foot |
| 7.1 to 12 feet | 2.0 feet |
| More than 12 feet | 3.0 feet |

The locations of the reaches determined for the flooding sources of Morton County are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

### 5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

### 5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.



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| FLOODING SOURCE | PANEL[1] | ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND | | | FLOOD HAZARD FACTOR | ZONE | BASE FLOOD ELEVATION (FEET NGVD)[3] |
|---|---|---|---|---|---|---|---|
| | | 10% (10-YEAR) | 2% (50-YEAR) | 0.2% (500-YEAR) | | | |
| Missouri River | | | | | | | |
| Reach 1 | 0230,0235 0240,0245 0485,0515 0780,0785 0795 | -2.2 | -1.1 | 3.0 | 020 | A4 | Varies - See Map |
| Heart River | | | | | | | |
| Reach 1 | 0515 | -0.5 | -0.2 | 0.5 | 005 | A1 | Varies - See Map |
| Reach 2 | 0480 | -3.0 | -1.0 | 4.2 | 030 | A6 | Varies - See Map |

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORTON COUNTY, ND
(UNINCORPORATED AREAS)

# FLOOD INSURANCE ZONE DATA

MISSOURI RIVER-HEART RIVER

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| | |
|---|---|
| Zone A: | Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined. |
| Zones A1, A4, and A6: | Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs. |
| Zone B: | Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other local water-control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided. |
| Zone C: | Areas of minimal flood hazard; not subdivided. |
| Zone D: | Areas of undetermined, but possible flood hazard. |

The flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are summarized in Table 3.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Morton County is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the NFIP.

## 6.0 OTHER STUDIES

The hydrologic information presented in the 1974 Flood Plain Information report for the Missouri River, (Reference 5) was updated by the COE in 1982 (Reference 1) to reflect refinements in the potential operating procedures of the Missouri River Reservoirs. The 1982 updated hydrology was adopted for this study.



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Results of the Flood Insurance Studies for the Cities of Mandan and Bismarck and the unincorporated areas of Burleigh County, North Dakota (References 12, 13, and 14), are in agreement with the results of this Flood Insurance Study.

Flood Plain boundaries delineated for this study are not in exact agreement with the Map of Flood-Prone Areas in the vicinity of Mandan (Reference 15). Differences in delineation exist because more detailed methods were used to determine flood hazards for this Flood Insurance Study.

## 7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Denver Federal Center, Building 710, Denver, Colorado 80225-0267.

## 8.0 BIBLIOGRAPHY AND REFERENCES


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13. Federal Emergency Management Agency, Flood Insurance Study, City of Bismarck, North Dakota, September 18, 1985

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15. U.S. Department of the Interior, Geological Survey, Map of Flood-Prone Areas, Scale 1:24,000, Contour Interval 10 feet: Mandan, North Dakota (1969)



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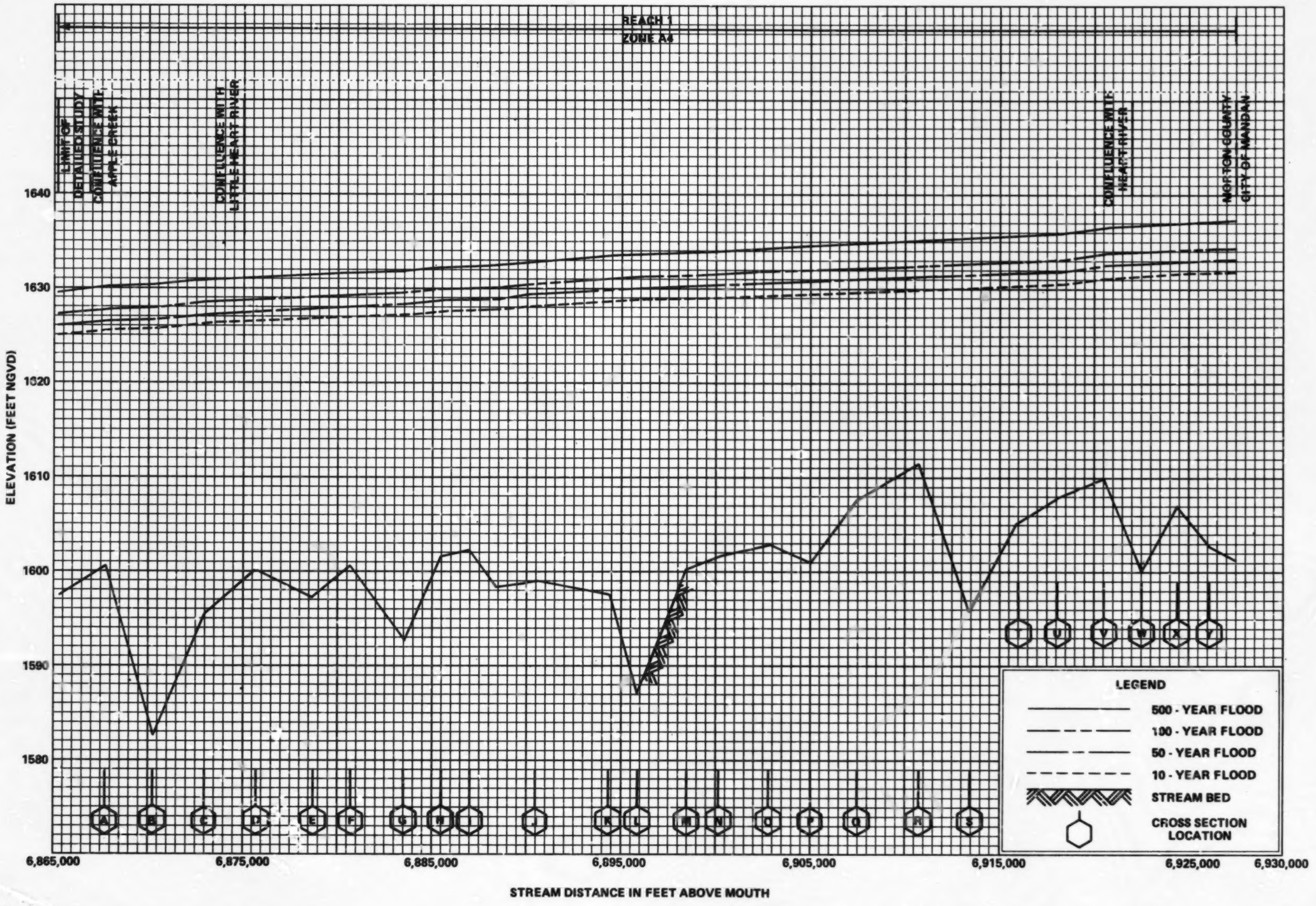


FLOOD PROFILES

MISSOURI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORTON COUNTY, ND
(UNINCORPORATED APEAS)

01P



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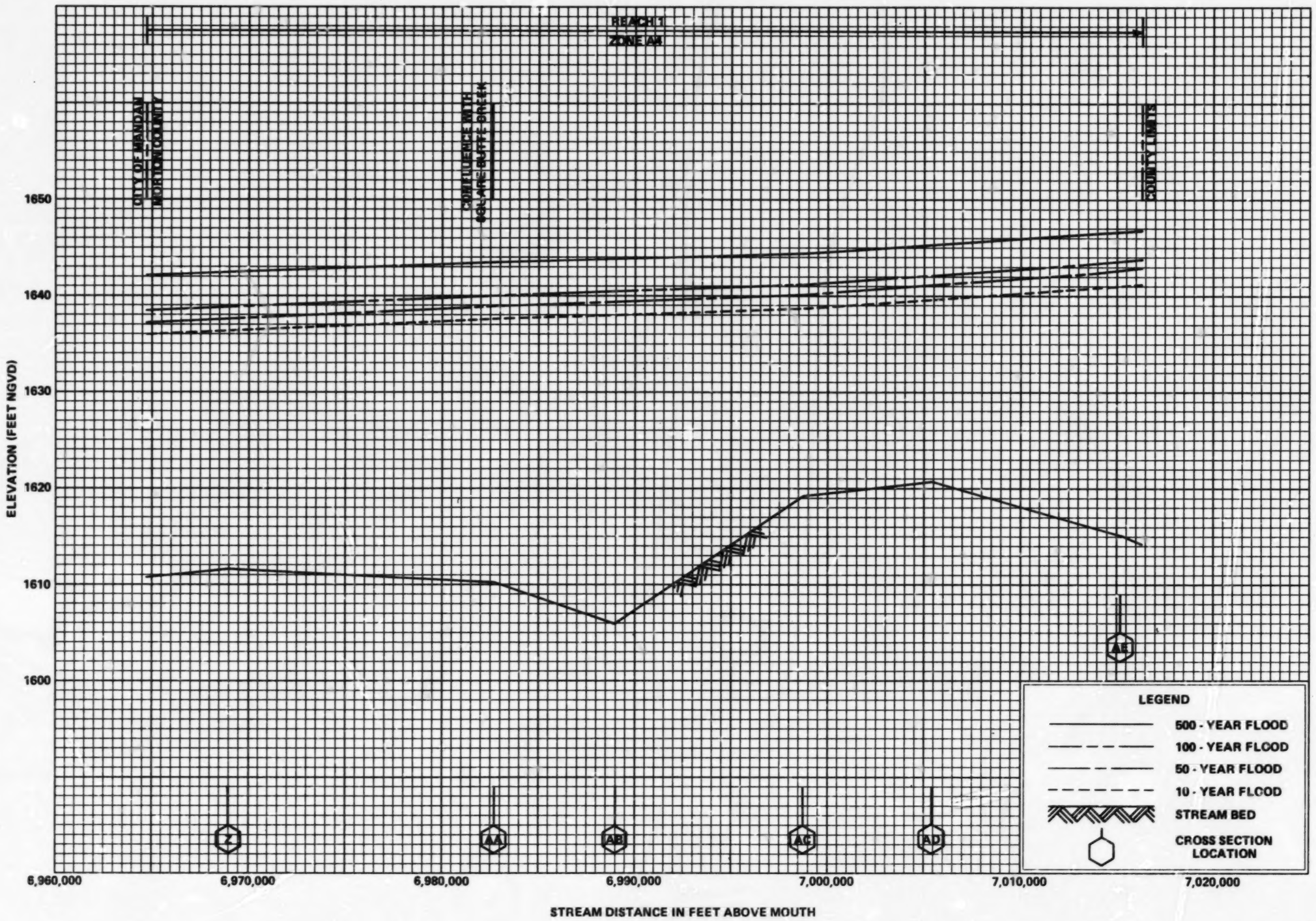


**FLOOD PROFILES**

MISSOURI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORTON COUNTY, ND
(UNINCORPORATED AREAS)

**02P**



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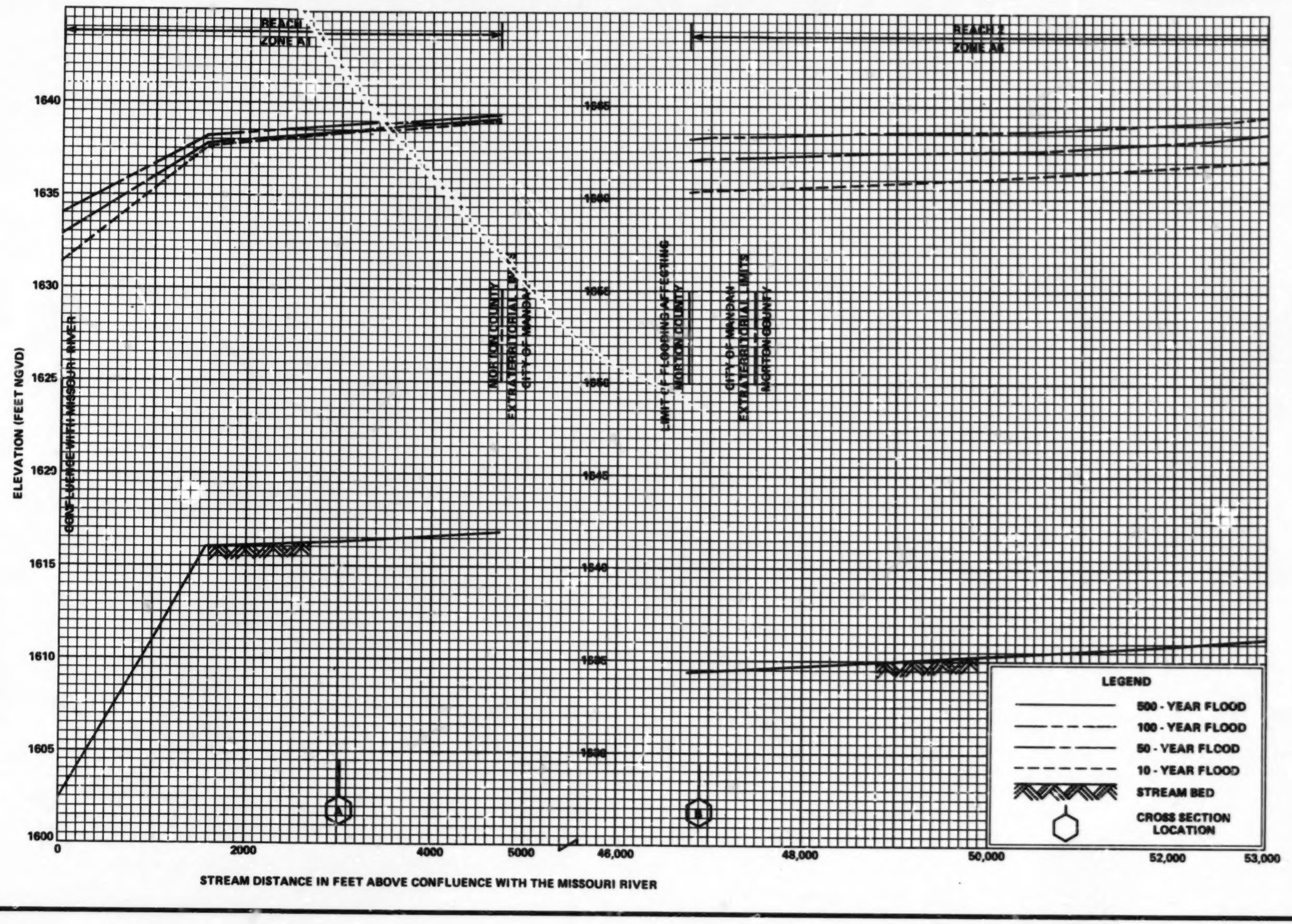


# FLOOD PROFILES

## HEART RIVER–WITH CONSIDERATION OF LEVEES

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORTON COUNTY, ND
(UNINCORPORATED AREAS)

03P



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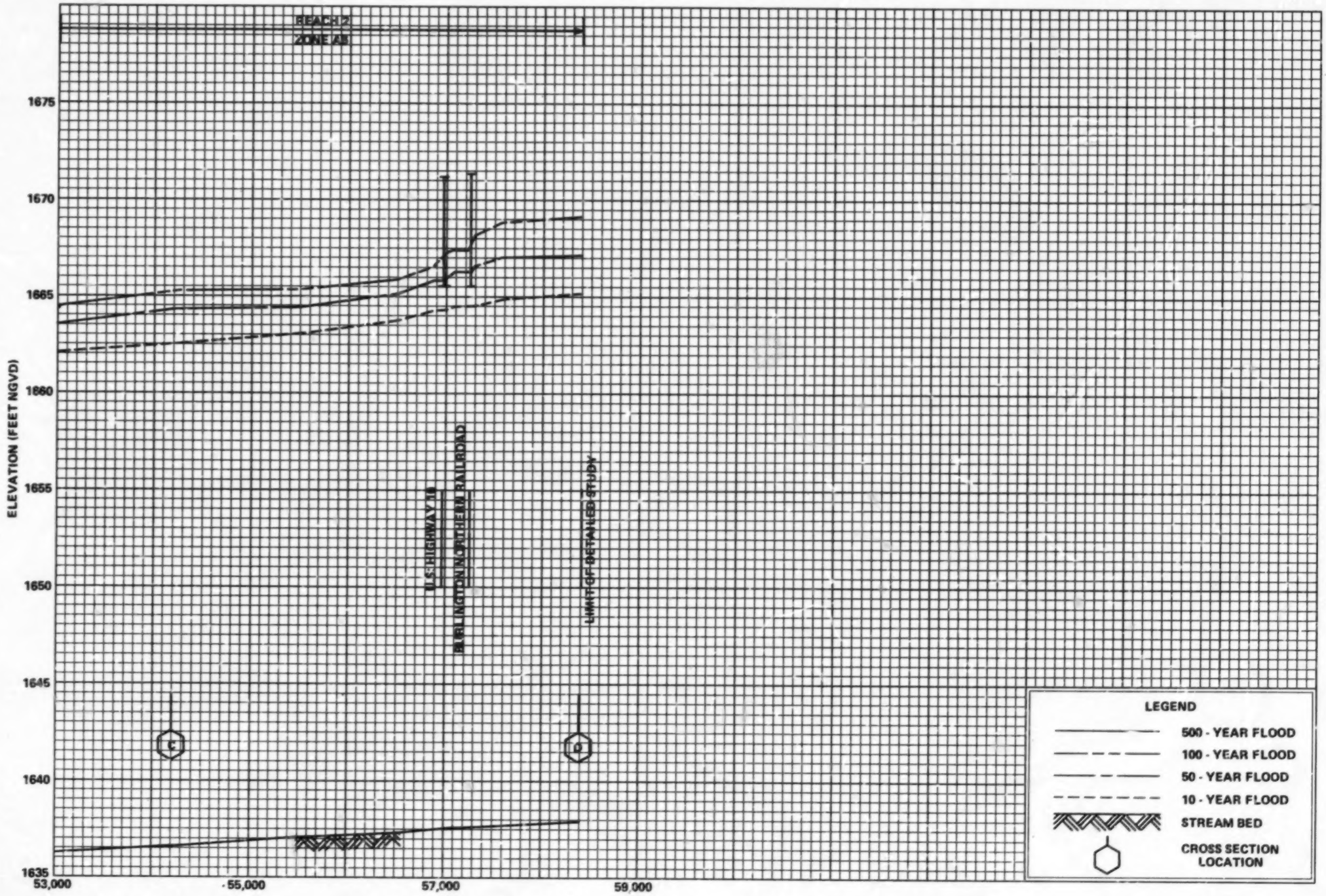


**FLOOD PROFILES**

HEART RIVER–WITH CONSIDERATION OF LEVEES

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORTON COUNTY, ND
(UNINCORPORATED AREAS)

04P



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